



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification: B32B 5/26, B29C 65/00, B32B 7/12, D04H 13/00	A1	(11) International Publication Number: WO 00/44556 (43) International Publication Date: 03 August 2000 (03.08.2000)
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(21) International Application Number: PCT/US00/00905

(22) International Filing Date: 17 January 2000 (17.01.2000)

(30) Priority Data:
09/240,738 29 January 1999 (29.01.1999) US

(60) Parent Application or Grant
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Published

(54) Title: HIGH STRENGHT THROUGH-BONDING TECHNIQUE FOR ELASTOMERIC LAMINATES
(54) Titre: TECHNIQUE DE COLLAGE TRAVERSANT A RESISTANCE RENFORCEEC LAMINATES

(57) Abstract

The fabrication of multi-layered laminated structures involves a high strenght through-bonding technique. In its preferred embodiment, the structure is a nonwoven trilaminate structure which has outer layers (12, 18) of nonwoven material, and an inner elastomeric layer (16) which has a plurality of openings (20) therethrough, (e.g., an elastomeric mesh). During fabrication, beads of through-bonding adhesive (e.g., oil resistant, polybutylene-based hot melt adhesive) is applied to at least one of the nonwoven webs. The inner elastomeric mesh web and the two outer nonwoven webs are then aligned and fed into a compression nip. The compression nip compresses the webs together to obtain intimate contact of the two outer nonwoven webs through the openings in the inner elastomeric mesh web. In the resultant trilaminate web, the inner elastomeric mesh layer is mechanically secured within the trilaminate structure via the through-bonding even if bonds directly between the inner elastomeric mesh and either of the outer nonwoven webs fail. Preferably, the beads of through-bonding adhesive are applied only in regions of the web where strenght enhancement is desired to insure the integrity and durability of the finished product, e.g. adjacent the longitudinal edges of the finished nonwoven trilaminate product.

(57) Abrégé

L'invention porte sur la fabrication de structures laminées multicouches recourant à une technique de collage traversant à résistance renforcée. Dans l'exécution préférée, la structure est un trilaminé présentant deux couches extérieures (12, 18) de non tissés et une couche intérieure (16) d'élastomère (20) ajourée (par exemple un canevas). Pendant la fabrication, on applique des cordons d'adhésif traversant (par exemple un adhésif thermofusible oléorésistant à base de polybutylène) sur au moins l'un des non tissés. Les couches extérieures et le canevas intérieur, mis en regard, sont introduits dans la pince d'un dispositif de compression qui met les deux couches extérieures en contact intime à travers les jours du canevas. Dans la bande trilaminée résultante le canevas se trouve fixé mécaniquement à l'intérieur de la structure trilaminée par le collage traversant même en l'absence de liaisons directes entre le canevas et l'une des couches extérieures. Les cordons de colle ne sont de préférence appliqués qu'aux zones de la structure dont on désire le renforcement pour assurer l'intégrité et la durabilité du produit fini, par exemple le long de ses bords longitudinaux.

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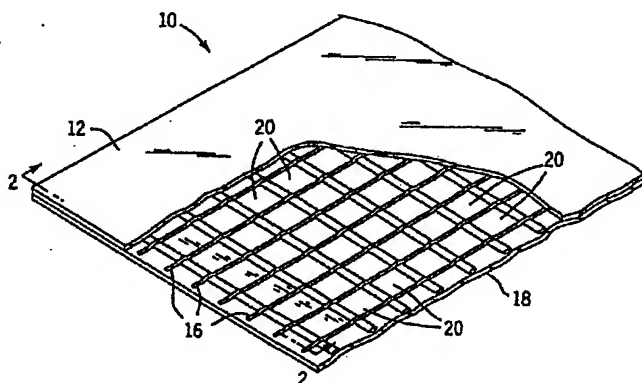
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(51) International Patent Classification 7 : B32B 5/26, 7/12, D04H 13/00, B29C 65/00		A1	(11) International Publication Number: WO 00/44556
			(43) International Publication Date: 3 August 2000 (03.08.00)
(21) International Application Number: PCT/US00/00905		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 17 January 2000 (17.01.00)		<p>Published With international search report.</p>	
(30) Priority Data: 09/240,738 29 January 1999 (29.01.99) US			
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(54) Title: HIGH STRENGTH THROUGH-BONDING TECHNIQUE FOR ELASTOMERIC LAMINATES



(57) Abstract

The fabrication of multi-layered laminated structures involves a high strength through-bonding technique. In its preferred embodiment, the structure is a nonwoven trilaminar structure which has outer layers (12, 18) of nonwoven material, and an inner elastomeric layer (16) which has a plurality of openings (20) therethrough, (e.g., an elastomeric mesh). During fabrication, beads of through-bonding adhesive (e.g., oil resistant, polybutylene-based hot melt adhesive) is applied to at least one of the nonwoven webs. The inner elastomeric mesh web and the two outer nonwoven webs are then aligned and fed into a compression nip. The compression nip compresses the webs together to obtain intimate contact of the two outer nonwoven webs through the openings in the inner elastomeric mesh web. In the resultant trilaminar web, the inner elastomeric mesh layer is mechanically secured within the trilaminar structure via the through-bonding even if bonds directly between the inner elastomeric mesh and either of the outer nonwoven webs fail. Preferably, the beads of through-bonding adhesive are applied only in regions of the web where strength enhancement is desired to insure the integrity and durability of the finished product, e.g. adjacent the longitudinal edges of the finished nonwoven trilaminar product.

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Description

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HIGH STRENGTH THROUGH-BONDING TECHNIQUE FOR ELASTOMERIC LAMINATES

FIELD OF THE INVENTION

The invention relates to laminated structures that are useful in the construction of disposable articles, e.g. diapers, etc. In particular, the invention relates to a high strength, through-bonding technique that enhances the strength and durability of stretchable laminates.

BACKGROUND OF THE INVENTION

Many commercially available disposable articles include laminated components which are breathable and stretchable, for example absorbent articles like disposable diapers for infants and undergarments for incontinent adults use stretchable side panels. Many, if not most, of these disposable articles use layers of nonwoven material. Other products which use nonwoven laminates include bandages, body wraps, and the like.

Several types of nonwoven fabrics are known in the art. In general, nonwoven fabrics contain fibers of polyethylene, polypropylene, polyethylene terephthalate, nylon, or rayon and are joined in any number of ways for example adhesives, thermal bonding, felting, or other methods known in the art. Thermally bonded nonwoven polypropylene is particularly prevalent in disposable articles. Thermally bonded nonwoven polypropylene is breathable and has a soft, cloth-like feel which is particularly suitable for these applications.

The assignee of this application has been involved in the development of various adhesives for use in nonwoven laminated structures, e.g. see copending U.S. Patent application Serial No. 08/632,117 entitled "Oil Resistant Polybutylene Based Hot Melt Adhesive" filed on April 15, 1996 by Bonnie M. Harris and Monina Kanderski; and U.S. Patent application Serial No. 08/914,523 entitled "Hot Melt Adhesive Having a High Acid Number for Disposable Soft Goods", filed on August 19, 1997 by Mark D. Alper and Diane Strelow, both incorporated herein by

5 reference. As discussed in the above incorporated patent applications, it is difficult
to find adhesives that are effective for bonding nonwoven material to the elastomeric
10 films or meshes which are desirable for use in nonwoven laminate structures. Some
elastomeric films or mesh webs (e.g., oil resistant materials or materials embodying
5 incompatible process aids) are simply difficult to laminate with nonwoven fabric. In
addition, effective and durable bonding to elastomeric film or mesh is particularly
15 difficult because of the mechanical stresses put on the bonds when the laminated
structure is repeatedly stretched.

The following discussion regarding elastomeric films and meshes is
10 added to provide a more complete explanation of some of the difficulties encountered
when fabricating laminated structures with commercially available elastomeric films
or meshes.

Commercially available elastomeric films and meshes are typically
25 manufactured from A-B-A block copolymers such as styrene-butadiene-styrene
(SBS), styrene-isoprene-styrene (SIS), styrene-ethylene/butylene-styrene, as well as
15 other polyolefins such as, but not limited to, ethylene vinyl acetate (EVA), and low
density polyethylene (LDPE). These elastomeric materials typically include about
20% to about 30%, by weight, of the elastomeric block copolymers, and about 20%
30 to about 30%, by weight, of other polyolefins, or ethylene vinyl acetate. An example
of these films and the specifics of their composition can be found in U.S. Patent No.
35 4,476,180. Once these elastomeric webs are formulated and extruded, the webs can
be very tacky. The tackiness makes it difficult to process the web on the extrusion
line, and in subsequent converting equipment. To address problems associated with
40 the tackiness of the elastomeric web, manufacturers of the elastomeric webs usually
incorporate a relatively high amount of slip agent into their formulations. For
25 example, fatty acid amides having the formula $\text{CH}_3 - \text{R} - \text{CO} - \text{NH}_2$ are commonly used
as slip agents. The letter R is a chain of repeating $-\text{CH}_2-$ units typically about 12 to
45 24 carbon atoms in length. The most commonly used fatty acid amide is Erucamide.
It is commercially available under the trade name Kemamide E from the Humko-

5 Sheffield Chemical Company. This particular slip agent has a carbon chain which is
22 units long, a molecular weight of about 337.6, and a capillary melting point of
about 82° C.

10 The slip agents incorporated into the elastomeric films and meshes
5 have caused significant problems for prior art hot melt adhesives which are
commonly used in the production of nonwoven laminates. In particular, it is
15 believed that the slip agents become mobile, under specific environmental
circumstances, or are otherwise incompatible with the polymers used in the
elastomeric films or meshes; and, these two factors combine to cause the slip agents
20 to migrate to, or otherwise to become deposited on, or "bloom" to, the exterior
surface of the film or mesh. The slip agents have a waxy nature, and they act as a
lubricant once they bloom to the surface of the film or mesh. For the manufacturers
of elastomeric film and meshes, this provides two valuable benefits. The first benefit
25 is that the presence of the waxy layer on the exterior surface of the film or mesh
15 helps prevent adjacent layers of film from adhering thereto (known in the industry as
"blocking") when it is placed into a roll form. The second benefit is that the waxy
30 layer acts as a lubricant, thereby facilitating the use of the film when it is unwound,
and later processed over rollers, guides, etc. during subsequent converting and/or
processing.

35 20 While the slip agents referred to above facilitate and even enhance the
use of these synthetic films and meshes in manufacturing, the slip agents which
migrate to the exterior surface of the film or mesh appear to destroy, or substantially
weaken bonds of prior art adhesives. The amount of slip agent present in the films
40 currently in commercial production ranges from about .1% to 1%, by weight,
25 although some films currently in production have as much as 4.5%, by weight. A
further disclosure of the use of slip agents in films or meshes can be found in U.S.
45 Patent Nos. 4,476,180, 4,977,014 and 4,714,735, all of which are incorporated by
reference herein.

5 In view of the difficulty surrounding the application of hot melt
adhesives to elastomeric films and meshes, the industry has long sought a hot melt
10 adhesive composition which would effectively bind these elastomeric films and
meshes to breathable materials, such as nonwoven webs.

5 SUMMARY OF THE INVENTION

In contrast to prior attempts to develop improved adhesives, the
15 invention involves the use of a high strength through-bonding fabrication technique
for elastomeric laminates. In its preferred embodiment, the laminated structure
includes two outer layers of nonwoven material and an inner elastomeric layer
20 10 laminated between the outer nonwoven layers. The inner elastomeric layer is
preferably a mesh, and in accordance with the invention, must provide openings
therethrough so that a bonding side of the first nonwoven outer layer is exposed
through the openings to a bonding side of the second nonwoven outer layer. An
25 important aspect of the invention involves the use of through-bond adhesive to
15 directly bond the first and second outer layers of nonwoven material to each other
through at least some of the openings in the inner layer. The direct bonds between
the nonwoven layers that occur through the openings in the elastomeric mesh
30 mechanically secure the elastomeric mesh within the trilaminate structure. In many
applications, it may also be desirable to provide adhesive for bonding the outer
35 20 nonwoven layers directly to the elastomeric mesh. It is the direct bond, however,
between the nonwoven layers that occurs through the openings in the elastomeric
mesh that is primarily responsible for enhancing the durability of the nonwoven
trilaminate structure.

40 In some nonwoven/elastomeric mesh trilaterates or like structures, the
25 nonwoven layers are not stretchable in the machine direction, but are spreadable in
the cross direction. The elastomeric mesh allows the trilaminate to stretch in the
45 cross direction when the trilaminate is stretched, and returns the trilaminate to the
relaxed position when the stretching ceases. In nonwoven trilaminate structures
where the outer nonwoven layers are bonded directly to the elastomeric mesh, but

5 not bonded to each other through openings in the mesh, repeated stretching tends to
promote delamination. This is due to the inherent difficulties in bonding elastic
materials. Using a through-bonding technique in accordance with the invention
10 substantially eliminates this problem, even when there is repeated stretching.

5 The invention is not limited to nonwoven elastomeric mesh
trilaminates. For example, the through-bonding technique improves durability of
laminated structures using types of breathable material other than nonwoven.
15 Further, the invention should not be limited to trilaminate (i.e., three ply) structures,
inasmuch as the structure could contain additional layers in accordance with the
20 invention.

In another aspect, the invention is a method of fabricating a breathable,
stretchable laminated web on a laminating machine which receives the two webs of
breathable material (e.g. nonwoven) and one web of the elastomeric material having
25 a plurality of openings therethrough. The method facilitates effective through-
bonding of the breathable layers through the openings in the elastomeric web. It
involves feeding a first web of breathable material into the laminating machine.
30 Separately from the first web of breathable material, a second web of breathable
material is also fed into the laminating machine. In addition, the elastomeric web
having a plurality of openings is also fed into the laminating machine. The webs are
35 aligned with the elastomeric web placed between the webs of breathable material.
Before the webs are completely aligned, through-bonding adhesive is applied on the
bonding side of at least one of the webs of breathable material. The through-bonding
40 adhesive is preferably applied in beads via a bead applicator, but could also be
applied using other known methods. The adhesive must be applied, however, under
25 conditions (e.g. temperature, viscosity, machine speed, compression force, etc.)
sufficient to allow the through-bonding adhesive to flow through the openings in the
45 elastomeric web and wet the bonding side of the other web of breathable material
when the webs are aligned and subsequently compressed together. The preferred
through-bonding adhesive is an oil resistant, polybutylene-based hot melt adhesive,

5 although the invention can be implemented using other types of through-bonding
adhesive. After the adhesive has been applied and the webs have been aligned, the
10 webs pass through a compression nip to achieve intimate contact between the wetted
bonding sides of the first and second webs of breathable material. It is preferred that
5 the compression force be at least 50 pounds per lineal inch. The preferred
compression nip is formed by a hard roller (e.g. steel) and a resilient roller (e.g.
15 rubber). Pneumatic cylinders can be used to control the compression force applied at
the compression nip. It is important that there be a sufficient amount of through-
bonding adhesive to wet the bonding side of both webs of breathable material
20 through the openings in the elastomeric web, and that there be sufficient compression
to insure intimate contact between the wetted bonding sides of the webs of breathable
material to facilitate proper bonding. The laminated web can then be longitudinally
25 sliced and perforated in the machine direction as is known in the art to create tear
lines and form a plurality of laminated webs.

15 It is preferred that the beads of through-bonding adhesive be applied to
the bonding side of one of the webs of breathable material, but not directly on the
30 second web of breathable material. Instead, a sprayed-on adhesive is preferably
applied on the second web of breathable material. Thereafter, the elastomeric web is
aligned and brought into contact with the second web of breathable material and
35 20 adhered thereto via the sprayed-on adhesive. Thereafter, it is preferred to spray-on
additional adhesive. The resulting web (i.e. the second web of breathable material
with the elastomeric web adhered thereto) is then aligned with the first web of
40 breathable material to which the beads of through-bonding adhesive have been
applied. The aligned webs then pass through the compression nip as described
25 above.

45 The preferred bead applicator has an adhesive plenum and a plurality
of adhesive application nozzles that may or may not be in contact with the bonding
side of the first web of breathable material. In order to facilitate application of a
sufficient amount of through-bonding adhesive, the nozzles can be arranged in a

5 series of diagonal rows. Inasmuch as a relatively significant amount of through-bonding adhesive should be applied to reliably secure the inner elastomeric layer within the trilaminate structure, the amount of through-bonding adhesive applied
10 during fabrication should be selected carefully, otherwise the finished product may become overly stiff. In many applications, it may be desirable to apply the through-bonding adhesive only along selected portions of the web (e.g. along the longitudinal
15 edges of the spliced laminated webs), thereby mechanically securing the inner elastomeric web within the trilaminate structure without creating an overly stiff finished product.

20 10 As should be apparent to those skilled in the art, the high strength through-bonding technique improves the durability of finished products using the laminated structure, without significantly compromising line speed of the lamination machine. Importantly, the through-bonding process and adhesive chemistry
25 overcomes adhesion difficulties caused by process aids (e.g. slip agents, oils, etc.) on elastomeric film or mesh when fabricating laminated structures. The invention is also likely to reduce costs associated with the development of new laminates. The
30 invention eliminates the need, at least in some circumstances, to find a suitable adhesive to bond a nonwoven layer directly to an inner elastomeric layer as is typically necessary during the development of conventional laminated structures.

35 20 Other features and advantages of the invention should be apparent to those skilled in the art upon inspecting the following drawings and descriptions thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

40 Fig. 1 is a perspective schematic view of a nonwoven trilaminate structure fabricated in accordance with the invention.
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45 Fig. 2 is a cross-sectional view of a nonwoven trilaminate structure manufactured in accordance with the invention taken along line 2-2 in Fig. 1.

Fig. 2a is a view similar to Fig. 2 showing the nonwoven trilaminate structure being stretched.

5 Fig. 3 is a schematic view illustrating a laminating machine that implements a high strength through-bonding technique in accordance with the invention.

10 Fig. 4 is an elevational view showing an adhesive bead applicator applying beads of through-bonding adhesive to a bonding side of a first outer nonwoven web.

15 Fig. 4a is a view of the nozzle arrangement for the bead applicator as viewed from line 4A in Fig. 4.

Fig. 5 is a schematic view illustrating the preferred adhesive application pattern used when implementing the invention.

20 DETAILED DESCRIPTION OF THE DRAWINGS

The drawings illustrate the best mode of carrying out the invention, however, it should be understood that the scope of the invention should not be limited to this preferred embodiment. Figs. 1, 2 and 2a illustrate a nonwoven trilaminate structure 10 constructed in accordance with the preferred embodiment of the invention. Figs. 3 through 5 relate to the preferred method of fabricating the nonwoven trilaminate structure 10.

Referring to Fig. 1, the nonwoven trilaminate structure 10 is formed from a first nonwoven layer 12 (i.e., a first layer of breathable material), an inner elastomeric layer 16, and a second nonwoven layer 18 (i.e., a second layer of breathable material). The elastomeric layer 16 is laminated between the first 12 and second 18 nonwoven layers. The elastomeric layer includes a plurality of openings 20 therethrough, and is preferably a stretchable elastomeric mesh. The preferred elastomeric mesh has a thickness of 0.025 inches, although other sizes of elastomeric mesh can be used in accordance with the invention. The trilaminate structure 10 can be incorporated into a variety of products when a soft, durable, breathable and elastic panel is desired. Examples of such products includes diapers, incontinence products, bandages, body wraps and the like.

5 In the preferred embodiment of the invention, the nonwoven layers 12, 18 are thermal bonded polypropylene. One example of a suitable nonwoven material has a basis weight of 63 gm per square meter, a tensile strength in the machine
10 direction of 7000 gm per inch, and in a cross direction of 425 gm per inch. Many other types of nonwoven materials can also be used in accordance with the invention.

Referring to Figs. 2 and 2a, the first outer nonwoven layer 12 has a
15 bonding side 14. The second outer nonwoven layer 18 also has a bonding side 22. Through-bonding adhesive 24 is applied to the trilaminate structure 10 and directly bonds the bonding side 14 of the first nonwoven layer 12 to the bonding side 22 of
20 the second nonwoven layer 18 through openings 20 in the elastomeric layer 16. It is not necessary when implementing the invention to apply the through-bonding adhesive 24 at all the openings 20 through the inner layer 16. The preferred through-bonding adhesive is a polybutylene based hot melt adhesive as disclosed in pending
25 U.S. Patent Application Serial No. 08/632,117 entitled "Oil Resistant Polybutylene Based Hot Melt Adhesive" by Bonnie M. Harris and Monina Kanderski filed on
15 April 15, 1996 which has previously been incorporated herein by reference. Other adhesives may also be suitable for use as the through-bonding adhesive. For example, the adhesives manufactured by Ato Findley, Inc. of Wauwatosa, WI and marketed under the name H9282F should be satisfactory.

20 Although not illustrated on Fig. 2 and not necessarily required for implementing the invention, it may be desirable to apply another adhesive on either (or both) of the nonwoven layers 12, 18 to provide adherence directly to the inner
35 layer 16. Preferably, this additional adhesive is sprayed-on. The preferred sprayed-on adhesive is an elastomeric, pressure sensitive adhesive such as the adhesive marketed under the name H2120 by Ato Findley, Inc. of Wauwatosa, Wisconsin, the
40 assignee of the present application.

45 The through-bonding adhesive 24 secures the respective bonding sides 14, 22 of the outer nonwoven webs through the openings 20 in the inner elastomeric layer 16 such that the strands of the elastomeric layer 16 are mechanically secured in
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5 the nonwoven trilaminate structure 10 even if the direct bonds between the
elastomeric layer 16 and either or both of the nonwoven layers 12, 18 fails. Fig. 2a
10 schematically illustrates the nonwoven trilaminate structure 10 being stretched. The
strands 16 of the inner elastomeric layer are not in general directly bonded to either
5 of the outer nonwoven layers 12, 18, as shown in Fig. 2a. Nonetheless, the strands
16 of the elastomeric layer are mechanically secured within the structure 10 by the
15 surrounding bonds 24 bonding the outer layers of nonwoven material through the
openings 20 in the elastomeric layer 16, even when the laminated trilaminate
structure is stretched.

20 In accordance with the invention, the average peel strength of the
through-bonding 24 that occurs between the nonwoven outer layers 12, 18 is greater
than the average peel strength of any bonds that may be present directly between the
25 elastomeric layer 16 and either outer nonwoven layer 12, 18. In fact, tests by the
assignee have shown that the peel strength of the bonds between the outer nonwoven
15 layers 12, 18 through the openings 20 and the elastomeric layer 16 are likely to be in
excess of two times greater than the peel strengths of bonds directly between the
30 elastomeric layer 16 and either nonwoven outer layer 12, 18.

The preferred method of fabricating the nonwoven trilaminate structure
10 shown in Figs. 1, 2 and 2a is now described in reference to Figs. 3, 4, 4a and 5.

35 Referring first in particular to Fig. 3, the nonwoven trilaminate 10A is fabricated in a
laminating machine 26 which preferably includes the components shown
schematically in Fig. 3. In Fig. 3, a first nonwoven web 12a is fed into the
40 laminating machine from a nonwoven roll unwinder as is known in the art. The first
nonwoven web passes over input roller 28 and is fed underneath a through-bonding
25 adhesive bead applicator 30. The through-bonding adhesive bead applicator 30
applies beads of the through-bonding adhesive on the bonding side of the first
45 nonwoven web 12a. A second nonwoven web 18a is also fed into the laminating
machine 26. In addition, the elastomeric web 16a is fed into the laminating machine
26, and passes over roller 32 to align the elastomeric web 16a with the second

5 nonwoven web 18a. If no machine direction stretch is desired, it is preferred that the
elastomeric web 16a be fed to the laminating machine 26 at or near zero tension,
otherwise the finished product can be distorted or deformed. Prior to introducing the
10 elastomeric web 16a, a conventional adhesive is sprayed on the bonding side of the
5 second nonwoven web 18a by sprayer 34. Subsequent to introducing the elastomeric
web 16a, additional adhesive is sprayed-on by sprayer 35. One of the purposes of the
15 sprayed-on adhesive is to bond the elastomeric web 16a directly to the bonding side
of the second nonwoven web 18a which can be important for maintaining proper
alignment of the elastomeric web 16a during the fabrication process. In the preferred
20 machine 26, the sprayers 34 and 35 spray adhesive in spiral patterns on the
nonwoven web 18a and the combination of the elastomeric web 16a and the
nonwoven web 18a, as is shown in Fig. 5, (row 52a by sprayer 34 and row 52b by
25 sprayer 35). Each row 52a, 52b is created by staggered rows of spiral patterns from
the respective sprayer 34, 35 to ensure complete coverage of the sprayed-on
15 adhesive. The sprayed-on adhesive is preferably selected to provide an effective
bond between the nonwoven web 12a and elastomeric web 16a. As mentioned
30 previously in connection with Fig. 1, the preferred adhesive is an elastomeric,
pressure-sensitive adhesive, for example, Ato Findley adhesive H2120 in the
preferred embodiment of the invention in which the inner web 16a is an elastomeric
35 20 mesh and the outer nonwoven web 18a is a thermally bonded nonwoven
polypropylene material.

The aligned second nonwoven web 18a and inner elastomeric mesh
40 web 16a pass over alignment roll 36 and continue towards compression nip 38. In
compression nip 38, the second nonwoven web 18a and elastomeric web 16a are
25 compressed against the first nonwoven web 12a which has beads of through-bonding
45 adhesive applied thereon. The aligned webs 12a, 16a and 18a are compressed
together with a sufficient amount of compression force to obtain intimate contact of
the wetted bonding side of the first nonwoven web 12a and the bonding side of the
50 second nonwoven web 18a even though the inner elastomeric mesh web 16a is

5 located therebetween. A compression force at compression nip 38 of approximately
50 pounds per lineal inch or greater has been found to be optimal for laminating the
10 preferred nonwoven trilaminate structure 10 described in conjunction with Figs. 1
and 2. Preferably, the compression nip 38 comprises a hard cylindrical roller 40
5 (e.g., a steel roller) and a resilient cylindrical roller 42 (e.g., a rubber roller). The
compression rollers 40, 42 are preferably mounted to pneumatically controlled
15 mounts on the laminating machine 26. One or more pneumatic cylinders 44 can be
used to control the amount of compression at the compression nip 38. Depending on
the specific trilaminate structure, the compression rollers 40, 42 at the nip 38 may or
20 may not have a fixed minimum gap or clearance therebetween. It is important,
however, that the amount of compression force at the nip 38 be selected so that the
through-bonding adhesive on the bonding side of the first nonwoven web of 12a
sufficiently wets the bonding side of the second nonwoven web 18a and initiates a
25 secure bond therebetween through openings 20 in the inner elastomeric layer 16a.
15 Downstream of the compression nip 38, the laminated web 10a can then be sliced
and perforated longitudinally by roller dies 46 as is known in the art.

30 The fabrication process as described thus far is able to produce
nonwoven trilaminates at relatively high speeds for example 200-300 feet per minute
machine speed or higher speeds. At such speeds, it is preferred to apply the through-
35 bonding adhesive via an adhesive bead applicator 30. Referring to Figs. 4 and 4a, the
bead applicator 30 includes a substantially rectangular adhesive plenum 48 and a
plurality of nozzles 50 extending downward from the plenum 48. The nozzles 50 are
40 arranged as a plurality of diagonal rows (see Fig. 4a). In the embodiment shown in
Figs. 4 and 4a, there are eight (8) nozzles per each diagonal row. Other nozzle
25 arrangements may be suitable.

45 Depending on the characteristics of the nonwoven web 12a and the
particular through-bonding adhesive, it may or may not be desirable for the nozzles
50 to be in contact with the nonwoven web 12a when the nonwoven web 12a passes

5 through the adhesive bead applicator 30 during machine operation. The through-
bonding adhesive add-on rate required to bond through the inner elastomeric web
16a is directly related to the thickness of the elastomeric web 16a. If the elastomeric
10 mesh web 16a is an elastomeric mesh material having a thickness of approximately
5 0.025 inches, the preferred add-on rate for through-bonding adhesive is
approximately 1.75 mg/lineal inch/bead. The through-bonding adhesive should be
15 applied to the nonwoven web 12a at a temperature sufficient to allow the adhesive to
flow through the elastomeric layer 16a and wet out the second nonwoven web 18a at
the speed in which the laminating machine is being operated. As mentioned, the
20 preferred through-bonding adhesive is an oil resistant, polybutylene-based hot melt
adhesive, such as that disclosed in copending U.S. Patent Application Serial No.
08/632,117, now U.S. Patent No. _____, and marketed by Ato Findley
25 under the name H9282F. It is preferred that this particular adhesive be applied to the
first nonwoven web 12a at a temperature of 320° F when applied in the contact
15 mode, and approximately 350-360°F when applied in the non-contact mode.

30 The open time for the through-bonding adhesive between the bead
applicator 30 and the compression nip 38 should be sufficiently short enough so that
the beads of through-bonding adhesive do not cool significantly or solidify. The
laminating machine 26 is operated effectively with an open time between the bead
35 20 applicator 30 and the compression nip 38 of approximately 1 second or less, although
depending on the materials used to fabricate the nonwoven trilaminate, it may be
possible to have longer open times for the through-bonding adhesive beads.

40 Fig. 5 illustrates the adhesive layout across the trilaminate web 10a.
The two rows of sprayed-on adhesive, which are sprayed on the second nonwoven
25 web 18a and the combination of the elastomeric web 16a and the second nonwoven
web 18a, are illustrated on Fig. 5 by reference numerals 52a, 52b. Each row includes
45 40 spirals as depicted in Fig. 5. Each of the spirals has a width of approximately 3/4

5 of an inch. The rows 52a, 52b are each formed by staggered rows of 20 spirals. The staggered rows promotes full coverage of the sprayed-on adhesive.

10 The beads 50 of through-bonding adhesive are applied only in certain selected areas as shown in Fig. 5. Fig. 5 shows slit lines 54 in web 10a as well as
5 perforation lines 56 in the web 10a. The beads 50 of through-bonding adhesive are applied only in the regions of the web 10a which are adjacent the perforation lines 56
15 and nearly adjacent the slit lines 54. In the preferred embodiment of the invention, the beads 50 in each group are spaced approximately 0.1 inches from one another. The application rate per bead is preferably 1.75 mg per inch as previously discussed.
20 (Ato Findley Adhesive H9282F for beads and Ato Findley Adhesive H2120 or H9282F for spirals). By applying the beads 50 only at locations on the web 10a which are adjacent to perforation lines 56 and nearly adjacent the slit lines 54, the
25 integrity of the finished product is improved inasmuch as the beads 50 serve to maintain the laminated structure, but the absence of the beads in the middle areas of
15 each individual web (i.e., each individual web is defined by a respective slit line 54 and perforation line 56) prevents each individual web from becoming overly stiff and
30 maintains relative softness of each individual web.

35 Peel strength tests were performed on samples of nonwoven trilaminated structures fabricated in accordance with the above described method,
20 except that the adhesive applied in beads (50 in Fig. 5) was absent. The test results indicated that the average peel strength of through-bonding that occurs directly
40 between the nonwoven outer layers 12, 18 is significantly greater than the average peel strength of any bonds that may be present directly between the elastomeric layer 16 and either of the outer nonwoven layers 12, 18. Samples were tested on an MTS
25 tensile tester using a standard test at a constant crosshead speed of 12 inches per minute. The test results were compared to samples in which release paper was
45 substituted for one of the nonwoven layers. It was necessary to run the peel tests without the adhesive applied in beads (50 in Fig. 5) because, otherwise, the peel tests

5 destructed the nonwoven layers. The individual results for the samples having the release paper are given below.

TABLE 1	
Sample	Avg. Peel (g/in)
1	119
2	156
3	148
4	147
5	153
Overall Avg.	144

The results for the nonwoven trilaminate samples (bead adhesive absent)

5 are given in Table 2:

TABLE 2	
Sample	Avg. Peel (g/in)
1	1708
2	1796
3	1332
4	1450
5	1485
Overall Avg.	1554

35 From the above peel strength test results, it is apparent that the average peel strength of the through-bonding that occurs directly between the nonwoven outer layers 12, 18 is significantly greater than average peel strength of any bonds
40 10 that may be present directly between the inner layer 16 and either of the outer nonwoven layers 12, 18. In addition, the application of bead adhesive (50 in Fig. 5) as is desired in accordance with the preferred embodiment of the invention increases the peel strength above the results shown in Table 2. It should therefore be apparent
45 to those skilled in the art that using a high strength through-bonding technique in
15 accordance with the invention can greatly improve the integrity and durability of nonwoven trilaminates.

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The invention has been described in conjunction with a preferred embodiment of carrying out the invention, however, the invention may be implemented in modified form without departing from the true scope or spirit of the invention. For example, the operating parameters (e.g., adhesive application rate, adhesive application method, adhesive application temperature, machine speed, adhesive viscosity, adhesive open time before compression, etc.) may vary substantially depending on the specific application. These parameters should be optimized not only to maintain integrity of the finished product, but also to maintain the integrity of the laminated structure during subsequent processing, handling and packaging. The scope of the invention should be determined in light of the following claims.

Claims

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CLAIMS

We claim:

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1. A multi-layer laminated structure comprising:

a first layer of breathable material;

a second layer of breathable material;

an elastomeric web layer having a plurality of openings therethrough,

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5 the inner layer being laminated between the first layer of breathable material and the second layer of breathable material, the elastomeric web layer being stretchable in at least one dimension; and

20

through-bonding adhesive that through-bonds the first and second layers of breathable material to each other through the openings in the inner elastomeric web layer, wherein an average peel strength of the through-bonding that occurs directly between the layers of breathable material is greater than the average peel strength of any bonds that may be present directly between the elastomeric layer and either layer of breathable material such that the elastomeric web layer is mechanically secured within the multi-layer laminate structure via the through-

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15 bonding which occurs directly between the layers of breathable material.

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2. A multi-layer laminated structure as recited in claim 1 wherein the elastomeric web layer is stretchable in two dimensions.

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3. A multi-layer laminated structure as recited in claim 1 wherein the layers of breathable material are layers of nonwoven material which do not stretch in a machine direction and are spreadable in a cross direction that is substantially perpendicular to the machine direction.

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4. A multi-layer laminated structure as recited in claim 1 wherein the through-bonding adhesive is chemically resistant to processing aids in the elastomeric web.

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5 5. A multi-layer laminated structure as recited in claim 1 wherein
the through-bonding adhesive is an oil resistant, polybutylene-based hot melt
adhesive.

10 6. A multi-layer laminated structure as recited in claim 1 wherein
the average peel strength of the through-bonding that occurs directly between the
15 outer layers of breathable material is more than two times greater than the peel
strength of any bonds that may be present between the elastomeric web layer and
5 either layer of breathable material.

20 7. A multi-layer laminated structure as recited in claim 1 further
comprising a sprayed-on adhesive that bonds at least one of the layers of breathable
material directly to the elastomeric web layer.

25 8. A multi-layer laminated structure as recited in claim 1 wherein
the layers of breathable material are outer layers of a trilaminate structure and the
elastomeric web layer is an inner layer of the trilaminate web structure.

30 9. A nonwoven trilaminate structure as recited in claim 8 wherein
the outer layers of breathable material are layers of nonwoven material.

35 10. A method of fabricating a multi-layer laminated web
comprising the steps of:
40 feeding a first web of breathable material into a laminating machine;
feeding a second web of breathable material into the laminating
45 5 machine;
feeding a web of elastomeric material into the laminating machine, the
elastomeric web having a plurality of openings therethrough;

5 aligning the webs such that the elastomeric web is placed between a
bonding side of the first web of breathable material and a bonding side of the second
10 web of breathable material;
10 applying through-bonding adhesive on the bonding side of the first
web of breathable material before the webs are completely aligned under conditions
sufficient to allow the through-bonding adhesive to flow through the openings in the
15 web of elastomeric material and wet a bonding side on the second outer web of
15 breathable material when the webs are compressed together; and
compressing the aligned webs together to obtain intimate contact of the
20 wetted bonding side of the first web of breathable material and the bonding side of
the second web of breathable material through openings in the web of elastomeric
material.

25 11. A method as recited in claim 10 wherein the through-bonding
adhesive is applied to the bonding side of the first web of breathable material via an
adhesive bead applicator.

30 12. A method as recited in claim 11 wherein the adhesive bead
applicator has one or more bead application nozzles in direct contact with the
35 bonding side of the first web of breathable material.

40 13. A method as recited in claim 11 wherein the adhesive bead
applicator has one or more bead application nozzles that are not in contact with the
bonding side of the first web of breathable material.

45 14. A method as recited in claim 10 further comprising the step of:
using a sprayed-on adhesive to directly bond the web of elastomeric
material to the second web of breathable material.

5 15. A method as recited in claim 14 wherein the sprayed adhesive is
sprayed on the bonding side of the second web of breathable material and the web of
10 elastomeric material is subsequently brought into engagement with the bonding side
of the second web of breathable material.

15 16. A method as recited in claim 10 wherein:
the web of elastomeric material is stretchable in at least one dimension;
and
the elastomeric web is fed to the laminator at near zero tension.

20 17. A method as recited in claim 10 wherein:
the web of elastomeric material is stretchable in two dimensions;
the elastomeric web has a thickness of approximately 0.025 inches; and
25 the through-bonding adhesive is applied by an adhesive bead
5 applicator at an approximate rate of 1.75 mg/lineal inch/bead.

30 18. A method as recited in claim 10 wherein the aligned webs are
compressed together using a compression force of at least 50 pounds/lineal inch.

35 19. A method as recited in claim 10 wherein the aligned webs are
compressed together using a compression nip formed by a hard roll and a resilient
roll.

40 20. A method as recited in claim 10 wherein the through-bond
adhesive is chemically resistant to processing aids in the elastomeric web.

45 21. A method as recited in claim 10 wherein the through-bonding
adhesive is an oil resistant, polybutylene-based hot melt adhesive.

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22. A method as recited in claim 10 wherein the first and second layers of breathable material are layers of nonwoven material.

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23. A method as recited in claim 10 wherein the through-bonding adhesive is applied by an adhesive bead applicator which comprises a plurality of bead application nozzles arranged in rows that are diagonal to the direction in which the first web of breathable material passes through the adhesive bead applicator.

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24. A method as recited in claim 10 wherein the through-bonding adhesive is also applied to a bonding side of the second web of breathable material..

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25. A method as recited in claim 10 wherein:
the aligned webs are compressed together using a compression nip
formed by a pair of compression rollers; and
one or more pneumatic cylinders regulate the amount of compression
provided by the compression nip.

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26. A method as recited in claim 10 wherein the through-bonding adhesive is characterized in that the average peel strength of the through-bonding between the layers of breathable material after the through-bonding adhesive solidifies is greater than the average peel strength of any bonds that may be present directly between the layer of elastomeric material and either of the respective webs of breathable material.

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27. A method as recited in claim 10 wherein the through-bonding adhesive is applied to the bonding side of the first web of breathable material at a temperature approximately in the range of 320° to 360° F.

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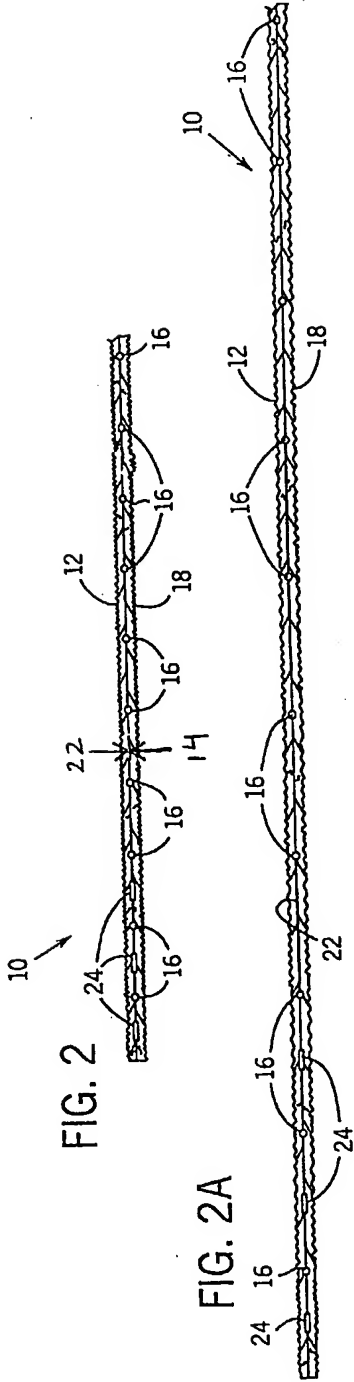
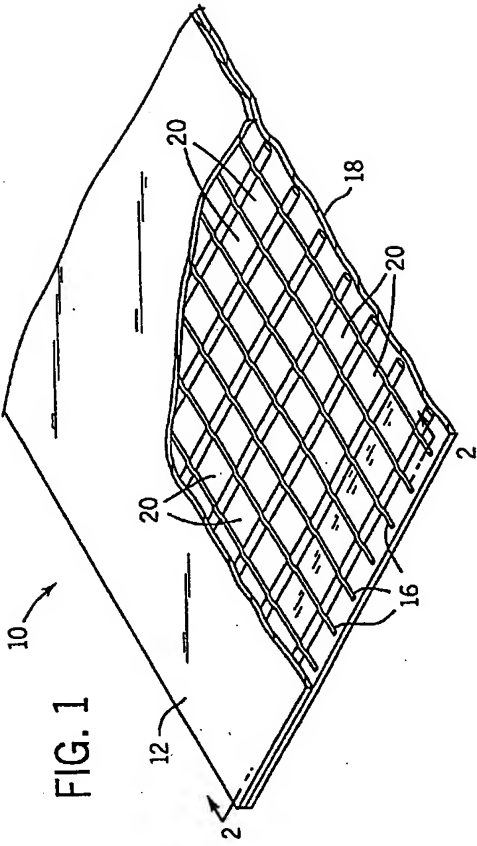
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28. A method as recited in claim 10 wherein the through-bonding
adhesive is applied by an adhesive bead applicator which comprises a plurality of
10 adhesive bead application nozzles, and the amount of through-bonding adhesive
applied to the bonding side of the first web of breathable material is not constant
5 across the web in a direction perpendicular to which the web passes through the
adhesive bead applicator.

15
29. A method as recited in claim 28 wherein beads of through-
bonding adhesive are not applied along selected portions of the bonding side of the
20 first web of breathable material.

30. A method as recited in claim 10 further comprising the step of:
25 longitudinally slitting the laminated web in the machine direction to
form a plurality of through-bonded trilaminate webs.

30
31. A method as recited in claim 30 further comprising the step of:
longitudinally perforating the laminated web in the machine direction
to form one or more longitudinal tear lines in the through-bonded trilaminate webs.



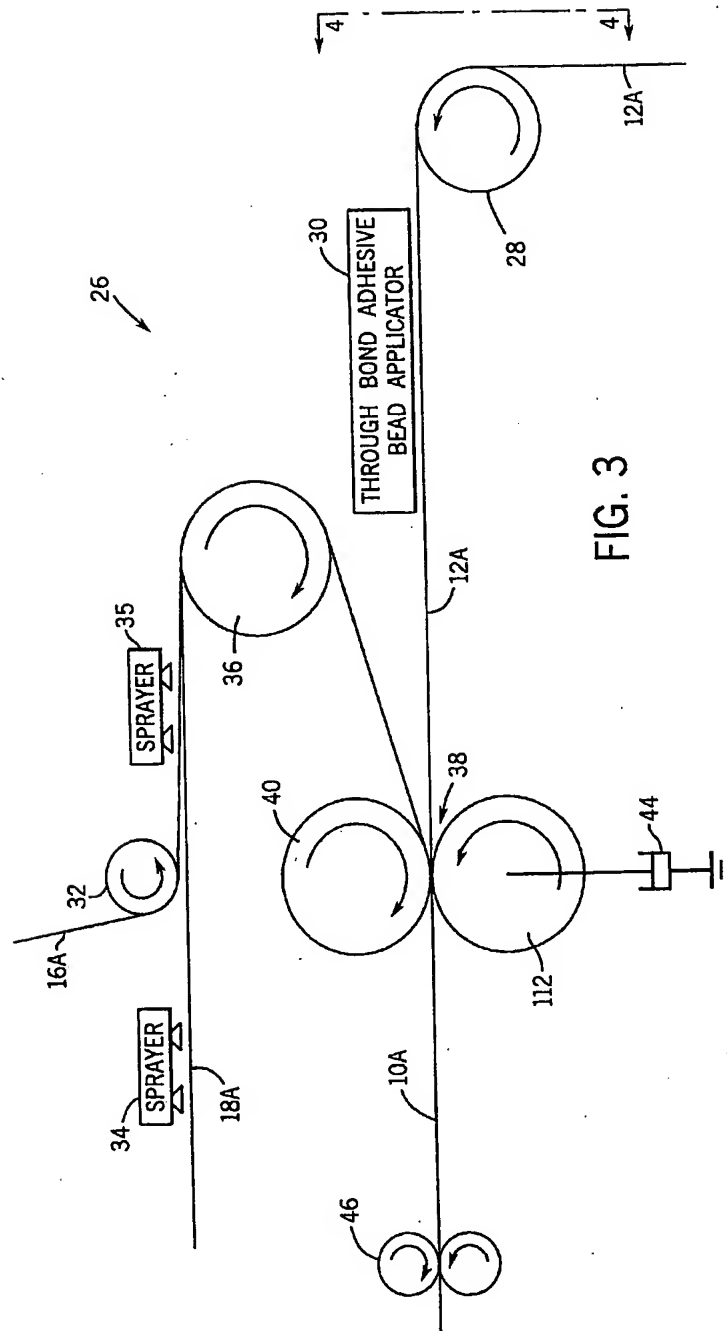


FIG. 3

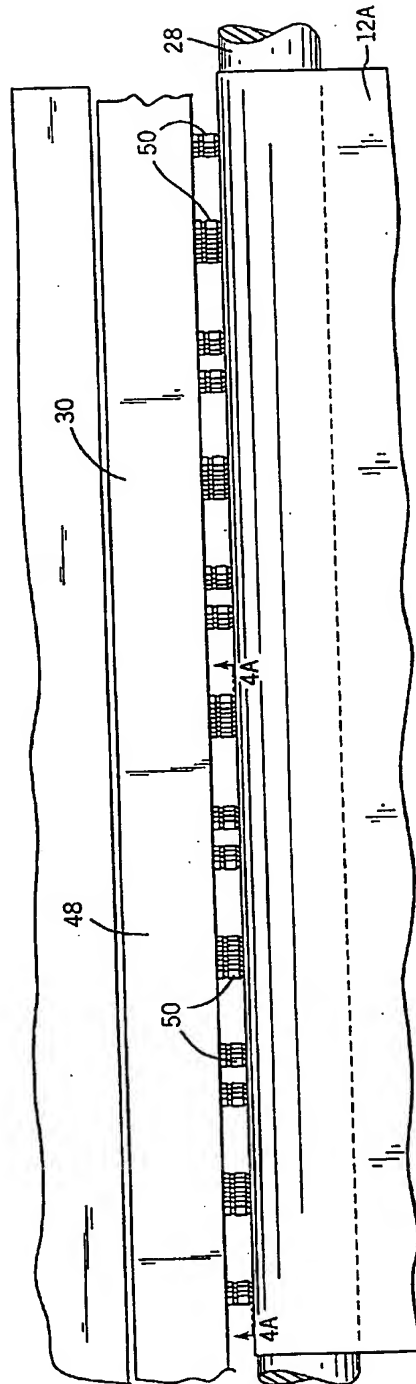


FIG. 4

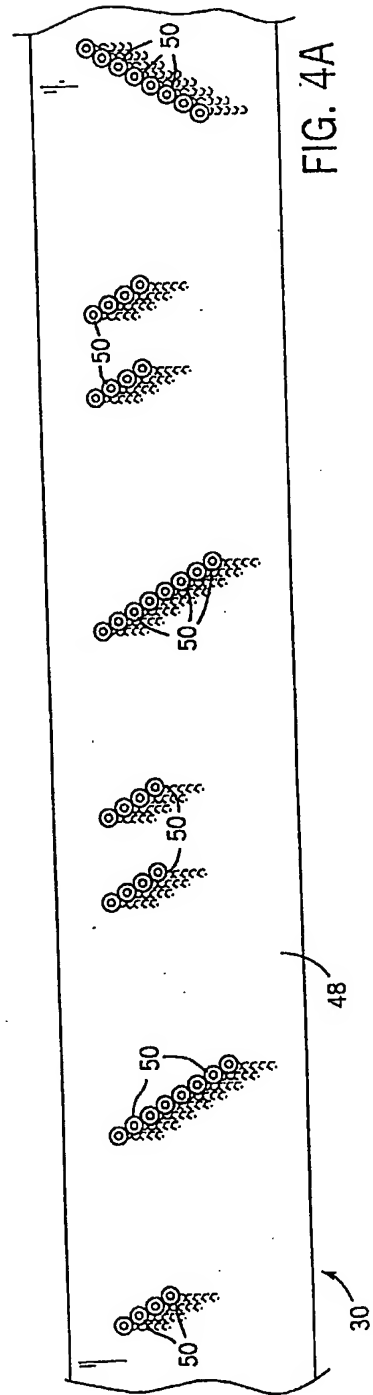


FIG. 4A

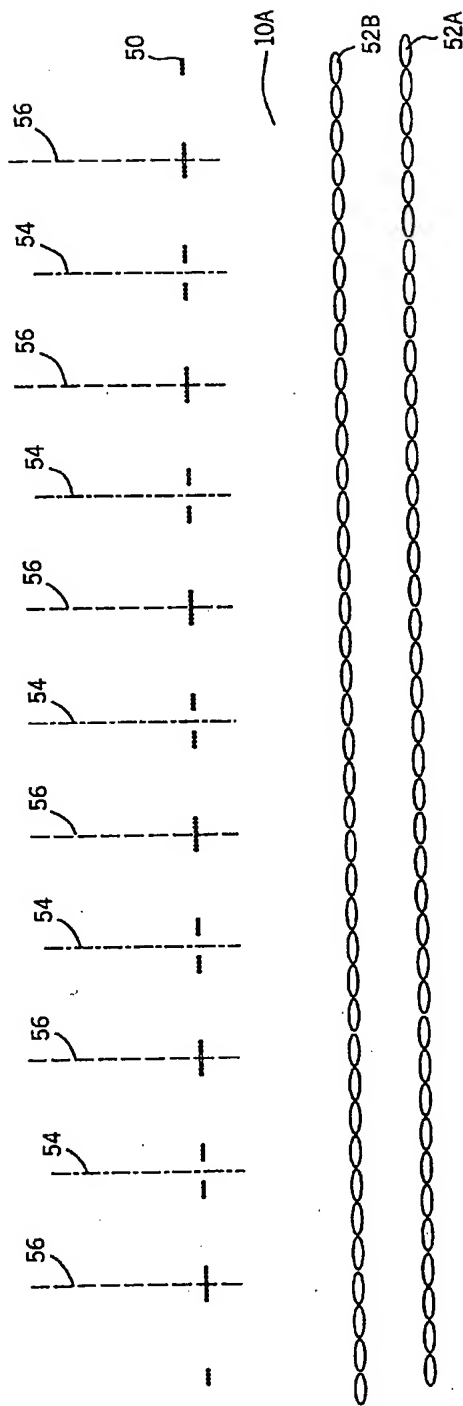


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/US 00/00905

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 B32B5/26 B32B7/12 D04H13/00 B29C65/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 B32B D04H B29C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 587 175 A (AKAO MUTSUO) 6 May 1986 (1986-05-06) column 1, line 35 - line 49 column 1, line 66 - line 68 column 3, line 65 - line 68 claims; figures	1-31
A	WO 96 38620 A (KIMBERLY CLARK CO) 5 December 1996 (1996-12-05) page 13, line 10 -page 15, line 2; claims; figure 1	1,10
A	US 4 229 473 A (ELBER WOLF) 21 October 1980 (1980-10-21) claims; figures	1-31
-/-		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
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Date of the actual completion of the international search 27 Apr11 2000		Date of mailing of the international search report 16/05/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-3040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer De Jonge, S

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G.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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